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(71) Applicant (for all designated countries except US):

Osram Opto Semiconductors GmbH & Co. OHG, Regensburg, Germany

(72) Inventor; and

(75) Inventor/Applicant (for US only):

Karlheinz Arndt, Regensburg, Germany

Gunter Waitl, Regensburg, Germany

Georg Bogner, Lappersdorf, Germany

(74) Agent: Epping Hermann & Fischer GBR, Munich, Germany

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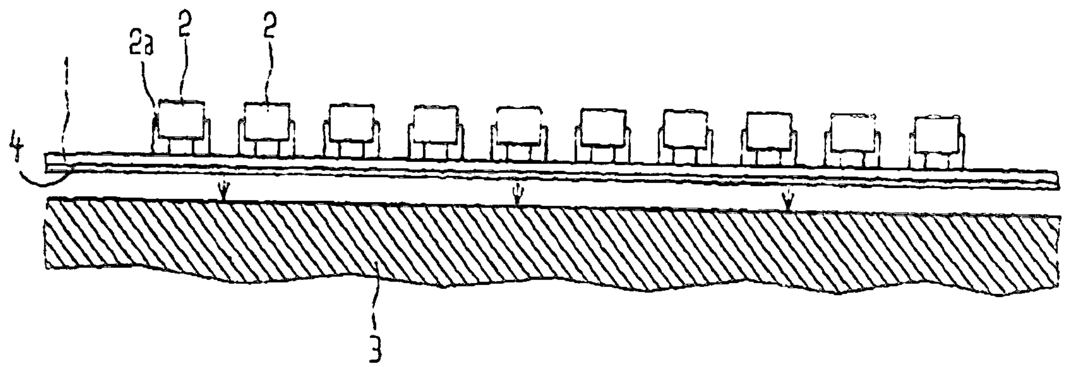

(57) Abstract

The invention relates to a light-emitting diode array that is surface-mounted on a board (1), such as a flexible board. The light-emitting diode array is mounted on a heat sink (3), so that the heat can be dissipated in an optimal manner. Said heat sink can take any form desired so that it is possible to design motor vehicle lamps, such as indicator lamps or similar, that can be adapted to the outer contour of the vehicle. In the case of a rotating lamp, the board (1) can be mounted around a heat sink that is configured as a cylindrical hollow body and can be operated rotationally.

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Description

LED Arrangement

The invention concerns an LED arrangement according to the preamble of Claim 1, which can be incorporated in particular in a light housing, as can be used, for example, in exterior lights of vehicles.

In the field of exterior and interior lighting of vehicles, especially for rear lights or brake lights and the like, light-emitting diodes (LEDs) are being increasingly used instead of conventional incandescent lamps, since LEDs have longer lifetime, better efficiency in conversion of electrical energy to radiation energy in the visible range of the spectrum and lower heat release connected with this and overall lesser space requirements. However, a certain additional expense must initially be incurred in design, since a number of LEDs formed into an array must be constructed because of the limited light density of an individual LED in comparison with an incandescent lamp.

This type of array can be mounted, for example, in surface mount technology (SMT) from a number of LEDs on a printed circuit board (PCB). An LED design is then used, as described for example, in the article "Siemens SMT-TOPLED for surface mounting" by F. Mollmer and G. Waitl in the journal Siemens Components 29 (1991), Vol. 4, p. 147 in conjunction with Figure 1. This form of LED is extremely compact and, if necessary, permits the arrangement of several such LEDs in a row or matrix arrangement.

Within the housing of such an LED, which is constructed, for example, based on InGaAlP and emits yellow or amber light, only about 5% of the electrical power is converted in the form of light, whereas about 95% is converted in the form of heat. This heat is taken off from the bottom of the chip via the electrical connections of the components. Depending on the design, in the components known by the applicant under the names TOPLED or Power TOPLED, the heat is either initially passed through one or three present cathode connections from the housing to the soldering points on the printed circuit board. The heat initially propagates from the soldering point mostly in the copper

pad and then in the epoxy resin material in the plane of the printed circuit board. The heat is then dissipated by heat radiation and heat convection over a large surface to the surroundings. In the case of an individual LED on FR4 circuit board material, the heat resistance is still relatively low (for example, about 180 K/W in an LED of the Power TOPLED® type).

However, the behavior is different when numerous LEDs are arranged right next to each other on a circuit board. Now a more limited surface is available for each individual LED on the PCB for heat transfer to the surroundings. The heat resistance from the PCB to the surroundings is higher accordingly. At a component spacing of, say, 6.5 mm, the heat resistance rises to as much as 550 K/W if the LEDs are of the Power TOPLED type and the printed circuit board is of the FR4 type.

Heat dissipation occurs from all heat-generating components on the circuit board, i.e., also from protective resistors, transistors, MOS-FETs or control ICs that are situated in the immediate vicinity of the LEDs. The operating current must be reduced so as not to destroy the component as a result of heat generation on the circuit board and deficient heat dissipation. Consequently, the light output of the LEDs cannot be fully utilized.

In the already mentioned field of illumination of vehicles, LED arrangements are used for the third brake light. This is a single-line array in which thermal problems still do not matter very much.

It is therefore the task of the present invention to modify an LED arrangement of the type just mentioned so that the light output of the LEDs can be used as optimally as possible. In particular, it is the task of the present invention to provide a surface-mounted LED arrangement characterized by improved heat dissipation from the LEDs. In addition, an LED arrangement is to be made available with which different spatial shapes of three-dimensional lighting elements can be simply implemented.

This task is solved by an LED arrangement with the features of Claim 1. The subsequent task is solved by an LED arrangement with the features of Claim 7. Advantageous modifications of the invention and preferred lighting devices with LED arrangements according to the invention are objects of Claims 2 to 6 and 8 to 16.

According to the invention, an LED arrangement with a printed circuit board and a number of LEDs preferably surface mounted on the printed circuit board is prescribed in which the printed circuit board is mounted on a heat sink on its side facing away from the LED and has a good heat-conducting layer on this side. The invention is therefore based on the finding that, in a surface-mounted LED arrangement of high LED density, in particular, heat dissipation to the rear must be supported.

The heat sink can consist of copper or aluminum or a cooling plate and the printed circuit board is preferably fastened to it with a heat-conducting paste, a heat-conducting glue, a heat-conducting foil or the like. On its backside, it is supposed to permit the best possible heat radiation. For this purpose, it can be painted black and/or have cooling ribs and/or a rough surface.

In addition, the printed circuit board should be as thin as possible, since the plastic material from which it is constructed generally conducts heat poorly. The printed circuit board can be a flexible printed circuit board, for example. The flexible printed circuit board is generally produced from a flexible plastic. It can consist of a polyester or polyimide film. Use of so-called flexboards known in the prior art is particularly preferred. These flexboards are generally multilayer printed circuit boards constructed homogeneously from a number of polyimide support films.

In addition, the copper paths around the soldering surfaces of LEDs applied with the surface mount technology (SMT) should be as large as possible in order to widen the heat path through the circuit board material before the heat flows to the backside of the circuit board. The main surface of the circuit board facing the heat sink is preferably laminated with copper or another metal in order to still permit heat conduction transversely to other glue sites when there are cavities in the lamination. The copper layer can be structured in meander-like fashion laterally to the circuit board in order to retain the flexibility of the circuit board.

In an LED arrangement according to the invention, a heat sink with a specific three-dimensional shape is used and a flexible printed circuit board, which is provided on a main surface with a number of LEDs, is laminated onto the deformed or curved surface of the heat sink. Three-dimensionally shaped LED modules based on specific

requirements can be produced because of this. An LED module can be adapted in space-saving fashion to the outer contour of the vehicle as a blinker, rear light, brake light or the like. A particularly practical example of this type is a rotating light in which the LED arrays are laminated onto flexboards around the cylindrical heat sink.

The LED arrangement can preferably be mounted with its circuit board on a good heat-conducting surface partial region of an instrument housing or autobody or the like. The instrument housing or autobody or the like advantageously acts here as heat sink. Among other things, this leads to lower technical manufacturing costs and a weight saving. These surface partial regions therefore represent the heat sink according to the present invention.

Additional advantageous modifications and preferred variants are further explained below by means of practical examples in conjunction with Figures 1A to 2C. In the figures:

Figure 1A shows a side view of a basic variant of the present invention in which the printed circuit board of a surface-mounted LED arrangement is fastened to a heat sink;

Figure 1B shows a schematic view of a possible structure of the heat-conducting layer and

Figure 2A to C shows modified variants of the present invention with different forms of the heat sink.

The basic variant depicted in Figure 1 contains a printed circuit board 1 on which a number of preferably surface-mountable LEDs 2 are applied. The printed circuit board 1 in known fashion then has a circuit that has connection surfaces for mounting of the LEDs at defined sites. These connection surfaces are provided, for example, in a surface mount device (SMD) assembly machine with soldering eyes and in a subsequent assembly step the LEDs 2 are soldered to these connection surfaces with their electrical contacts 2a.

The printed circuit board 1 can then be a rigid printed circuit board, for example, of the FR4 type and is therefore constructed essentially from an epoxy resin material. However, it can also be a flexible printed circuit board, like the aforementioned

flexboard. The printed circuit board 1 is laminated with a heat-conducting glue onto a heat sink 3 that consists of a cooling plate or is made from another metal, like copper or aluminum and therefore has high heat conductivity.

The main surface of the printed circuit board 1 facing the heat sink is laminated with a good heat-conducting layer 4, for example, with a copper layer or another metal layer in order to permit heat conduction transversely to the other glue sites when there are cavities in the lamination. The copper layer can be meandering, for example, (Figure 1B), in order to retain the flexibility of the printed circuit board.

The side of the heat sink 3 facing away from printed circuit board 1 is preferably configured so that heat dissipation to the surroundings is maximized. For this purpose, this surface is blackened and/or provided with cooling ribs and/or made with another appropriate surface structure or roughening.

Figure 2A to C shows how the invention can be advantageously utilized in order to produce specific three-dimensional light elements. In all depicted cases, a heat sink 3 with a desired shape is first produced, in which a surface is to be formed as light surface by applying an LED arrangement of surface-mounted LEDs 2. A flexible printed circuit board 1, like a flexboard, which is provided with an array of LEDs 2, is then laminated onto the heat sink 3.

Figure 2A shows, for example, in a side view an arbitrary curvature of the heat sink 3 that can be used with particular advantage for vehicle exterior lighting, like a blinker, rear light or brake light and the like, since it can be adapted in space-saving fashion to the outer contour of the vehicle. The heat sink, for example, can be formed directly from a surface partial region of an autobody (the headlight or rear light region of the fenders) or an instrument housing or the like.

An axial cross section of a rotating light is shown in the practical example of Figure 2B, as can be used, for example, in emergency vehicles. In the rotating light of Figure 2B, the flexboard 1 provided with an array of LEDs 2 is laminated around a cylindrical, hollow heat sink 3 formed as a tube. In this practical example, the LEDs of the array running parallel to the axis can additionally be combined into strands that are operated one after the other in the clockwise direction (see arrow) so that a rotating light

is produced. One strand or a certain number of adjacent strands can be operated at one time. The LEDs 2 can also be provided with lenses 4 for bundling of the emitted light. This variant has the major advantage that nearly all the mechanical parts that were previously necessarily for rotating lights of the conventional design drop out. If desired, the cylindrical heat sink 3 can also be traversed by a gas, like air or a cooling liquid, for further improvement of heat dissipation.

A three-dimensionally arched light dome is shown in a perspective view in Figure 2C. The light dome has a regular shape with an upper surface and four obliquely positioned side surfaces, two side surfaces of which are arranged in axial symmetry to each other. The heat sink itself is not visible in the depiction of Figure 2C, since it is fully covered by the flexboard 1. The flexboard 1 has a number of sectors corresponding to the surfaces of the heat sink in which a number of LEDs 2 arranged in an array are mounted. If desired, the LEDs 2 can be provided with lenses for bundling of the emitted light. This type of light dome can be used for lighting purposes of all types.

Claims

1. LED arrangement with

- a printed circuit board (1) and

- a number of LEDs (2) that are arranged on a main surface of printed circuit board (1),

characterized by the fact that

- the printed circuit board (1) is connected to a heat sink (3) with its side facing away from LEDs (2) and the printed circuit board (1) on its main surface facing heat sink (3) is provided with a good heat-conducting layer (4), especially a layer of copper or another metal with good heat conductivity.

2. LED arrangement according to Claim 1, characterized by the fact that the printed circuit board (1) is a flexible printed circuit board, especially a flexboard.

3. LED arrangement according to Claim 1 or 2, characterized by the fact that the good heat conducting layer (4) has a meandering or similar lateral structure.

4. LED arrangement according to one of the Claims 1 to 3, characterized by the fact that the heat sink (3) consists of metal, especially copper or aluminum or sheet metal.

5. LED arrangement according to one of the Claims 1 to 4, characterized by the fact that the surface of the heat sink (3) facing away from printed circuit board (1) is blackened and/or has cooling ribs and/or surface roughening.

6. LED arrangement according to one of the Claims 1 to 5, characterized by the fact that the LEDs (2) are provided with lenses (4).

7. LED arrangement with

- a printed circuit board (1) and

- a number of LEDs (2) that are arranged on a main surface of printed circuit board (1),

characterized by the fact that

- the printed circuit board (1) is a flexible printed circuit board, especially a flexboard, which is applied with its side facing away from LEDs (2) to a curved or singly

or multiply angled surface of a heat sink (3) or a good heat-conducting partial region of an instrument housing or an autobody or the like, so that the number of LEDs (2) are arranged in a three-dimensional shape stipulated by the curved or singly or multiply angled surface of the heat sink (3) or the like.

8. LED arrangement according to Claim 7, characterized by the fact that the printed circuit board (1) is provided with a good heat conducting layer (4), especially a layer of copper or another metal with good heat conductivity on its main surface facing heat sink (3).

9. LED arrangement according to Claim 7 or 8, characterized by the fact that the good heat conducting layer (4) has a meandering or similar lateral structure.

10. LED arrangement according to one of the Claims 7 to 9, characterized by the fact that the heat sink (3) consists of metal, especially copper or aluminum or sheet metal.

11. LED arrangement according to one of the Claims 7 to 10, characterized by the fact that the surface of the heat sink (3) facing away from printed circuit board (1) is blackened and/or has cooling ribs and/or surface roughening.

12. LED arrangement according to one of the Claims 7 to 11, characterized by the fact that the LEDs (2) are provided with lenses (4).

13. Lighting device with an LED arrangement according to one of the preceding Claims.

14. Lighting device with an LED arrangement according to Claim 13, characterized by the fact that

- it is an exterior light of the vehicle, like a blinker, rear light, a brake light or the like and

- the heat sink (3) has a curvature adapted to the outer contour of the vehicle or is a surface partial region of an autobody.

15. Lighting device according to Claim 13, characterized by the fact that it is a rotating light and the heat sink (3) is a cylindrical hollow element on whose outer wall the printed circuit board (1) is mounted.

16. Lighting device according to Claim 15, characterized by the fact that the LEDs of the array running parallel to the axis are electrically combined into strands that can be operated in rotation one after the other.

FIG 1

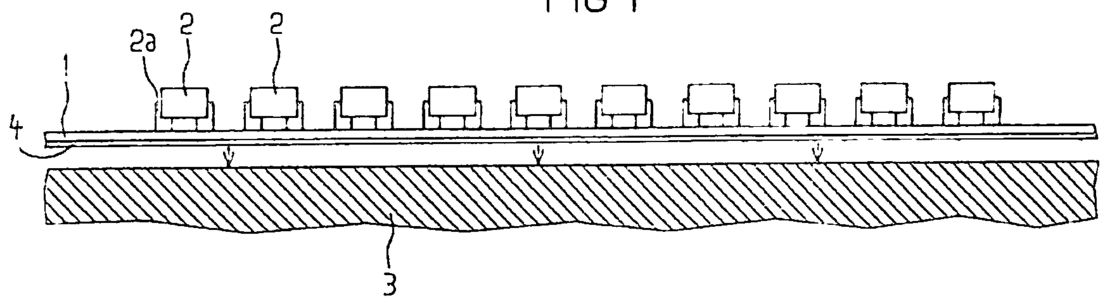

FIG 1B

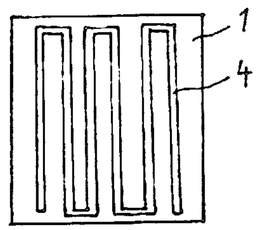

FIG 2A

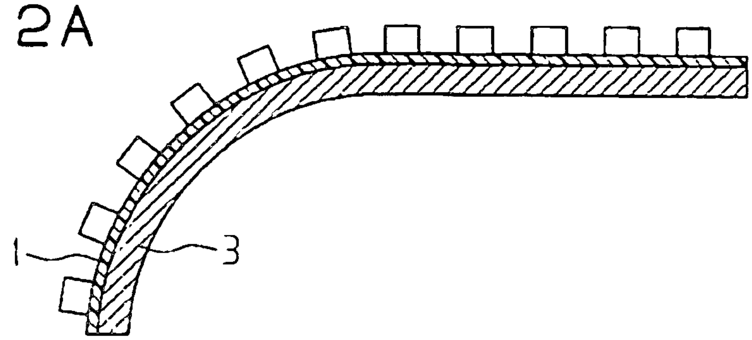

FIG 2B

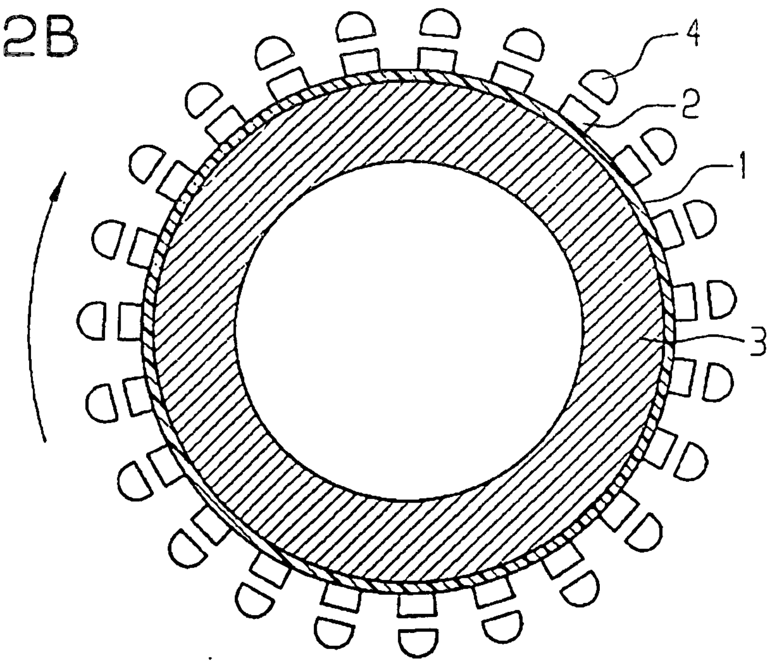

FIG 2C